

*Vol. 5, No. 1, 1926*

American Association of  
Jesuit Scientists

EASTERN STATES DIVISION

PROCEEDINGS  
of the  
FIFTH ANNUAL MEETING



GEORGETOWN UNIVERSITY,  
WASHINGTON, D. C.  
AUGUST 12 and 13  
1926



## Program of the Fifth Annual Meeting

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THURSDAY, AUGUST 12TH

10.00 A. M.—GENERAL SESSION—GASTON HALL:

Address of Welcome, Rev. Charles W. Lyons, S.J., President,  
Georgetown University.

Presidential Address, Rev. George F. Strohaber, S.J. "Anomalous  
Valences."

Appointment of Committees.

Miscellaneous Business.

3.00 P. M.—SECTIONAL MEETINGS—In the Respective Departments'  
Lecture Halls.

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FRIDAY, AUGUST 13TH

10.00 A. M.—SECTIONAL MEETINGS—In the Respective Departments'  
Lecture Halls.

3.00 P. M.—GENERAL SESSION—GASTON HALL.

Report of the Nominating Committee.

Reports of Other Committees.

Resolutions.

Miscellaneous Business.

Adjournment.

## PROCEEDINGS

The fifth annual meeting of the American Association of Jesuit Scientists (Eastern States Division) was held at Georgetown University, Washington, D. C., August twelfth and thirteenth.

The first general session was called to order at 10.00 A. M. by the President. In the absence of Rev. Charles W. Lyons, President of the University, a cordial welcome was extended to the Association by Fr. Dixon. After Fr. Dixon's welcome followed the

### Presidential Address

#### Anomalous Valences

Rev. George F. Strohaber, S.J.

With the enunciation of the periodic law, the mooted question of the variable character of valence received, so it seemed at that time, its answer from the periodic table of the elements. It became obvious that, generally speaking, the first three groups show a distinctly fixed valence capacity, from 1 to 3 respectively: in the fourth group the elements are equally divided between those with unvarying quadrivalence and those which can function with a valence lower than four. Beginning, however, with the fifth group, practically all the elements were judged to possess variable valence, ascending in number to 5, 6, 7, and 8 respectively, or descending to 3, 2, 1, according to whether oxygen or hydrogen was the measure of valence.

And yet, a certain regularity was read even into the variation itself. In the carbon group, the elements tin, lead—and later also germanium—were found to function either as quadrivalent or bivalent, but not trivalent. In the fifth group the variation was again by two, as  $\text{As}^{\text{III}}$  and  $\text{As}^{\text{V}}$ , and so in the oxygen group, as  $\text{S}^{\text{II}}$ ,  $\text{S}^{\text{IV}}$ , and  $\text{S}^{\text{VI}}$ , and finally in the halogen group, where the valence is 1, 3, 5, and 7. Exceptions to this general rule were not unknown, as for instance  $\text{TiCl}_3$  and  $\text{NO}$ , but they were so few in number as to be disregarded. There was known, in addition, a large class of compounds the existence of which could not very well be explained solely on the basis of atomic valences. These complex compounds—hydrates of salts, double salts, etc.—were looked upon as "Molecular compounds," in which normal molecules were held together not through atomic valences, but through some other force, through "molecular" attraction.

Such was the state of the valence idea some thirty years ago, when several new, independent, and diverse currents of thought were

initiated which finally brought about a profound change in the views concerning the immutability of valence. Only some of these currents can be mentioned here.

Werner's "Co-ordination Theory" assumes that in all the complex salts, the hydrated salts, the basic salts, and even in such simple compounds as  $\text{NH}_4\text{Cl}$ , the molecule is made thus: The principal atom is located in the center and around it are symmetrically packed, or "co-ordinated" a certain number of other atoms or groups, and each of the co-ordinated units is directly united to the central atom. Usually the co-ordination number is 6, and these 6 co-ordinated atoms or groups occupy the six corners of an imaginary octohedron; less frequently the co-ordination number is 4, and still less, 8; but it may also be 1, 3, 5, or 7, depending upon a variety of factors. In addition to the co-ordinated atoms or groups which are situated in the immediate vicinity of the central atom, the molecule contains several additional atoms or groups. These, however, must lie outside of the co-ordinated complex, since they may become readily dissociated away as ions from the complex. They lie, therefore, in a secondary zone, and the co-ordinated complex functions in respect to them as a single unit or ion.

In the desire to make the new views compatible with the teachings of the older valence hypothesis, Werner attempted to differentiate between the "true" valences which the atom presumably acquires in the formation of the co-ordinated compound. He named them accordingly principal or primary valences and auxiliary or secondary valences. Later, however, this distinction was found to be too indefinite, and with the recognition of the electronic nature of all valence phenomena, the artificial division into auxiliary and principal valences had to be abandoned. The successful application of the co-ordination theory in the classification and the study of thousands of inorganic and of many organic compounds is evidence that the theory contains a truly important generalization. Moreover, the theory withstood the same severe test to which the stereochemical theories in organic chemistry had been subjected, namely—the ability to predict the definite number of space isomers possible as well as the particular circumstances essential for the occurrence of optical isomerism in this group of inorganic compounds. The fact that the theory lends itself with only slight modifications, to a restatement in terms of the modern electron valence theory, is further evidence in favor of the essentially sound basis upon which the co-ordination theory rests.

What then is the operating valence of the central atom in these co-ordinated compounds? If we assume, as we must, that there is no intrinsic difference between the principal and the auxiliary valences with the co-ordination complex, then obviously the active valence of the co-ordinating atom is the same as its co-ordination number, and is, consequently, nearly always greater than the regular orthodox

valence. Thus, among the many important consequences of this theory, the following one is particularly apposite in the discussion of the mutability of valence: We have become accustomed to the idea that the valence capacity of an element is not delimited by the position of the element in the periodic table, but that it is a distinctly variable function and can rise to a much higher number than we have ever supposed in the past that it could do.

Of course, the greatest influence upon the chemist's views of valence came from the revolutionary transformation of the physicist's ideas concerning atomic structure, which transformation was initiated, among other causes, when J. J. Thompson in 1897 determined the mass of the electron, and showed that the nature of the electron is always the same from whatever element it may come. There is general agreement on the main point. In the center of the atom is a nucleus of positive electricity, and surrounding this an equal amount of negative electricity which is carried by electrons as many in number as is represented by the atomic number of the element. Only those electrons, however, which lie in the peripheral zone are directly engaged in the establishment of chemical bonds between two atoms—these alone are the "valence electrons." The number of valence electrons in the elements is a periodic function of the atomic numbers and varies from 0 up to 8, and the elements which occupy corresponding positions in the periods contain an equal number of valence electrons. Eight therefore is the maximum number of valence electrons, and this represents the most stable configuration. So chemical reaction, union among atoms, must tend towards the establishment of a sphere of eight valence electrons around the atoms which participate in the reaction. But even with the allowance that the valence electrons alone and no other electrons are concerned in the creation of chemical bonds between atoms, there still arises a multitude of perplexing questions when one tries to picture to himself the *modus operandi* of this process. If an active bond is created through the complete transference of one valence electron from atom A to atom B, then evidently the maximum bonding capacity of atom A is determined by the number of its valence electrons, and there is no inherent reason why atom A should not exhibit, under specific experimental conditions, every possible variation in valence between its maximum and zero. The same applies to the second atom in this transaction, the operative valence of atom B being measured by the number of electrons it has acquired from atom A. On the other hand, if it be assumed that a chemical bond can also be established when atoms share electrons, be it either in the statical or the dynamical sense, then the question arises how many electrons must be thus shared for each bond, how many atoms may partake simultaneously in the sharing of the same electrons. It becomes impossible to predict the maximum bonding

capacity of an atom unless some arbitrary postulates be introduced which would limit the variable factors mentioned. G. N. Lewis and Kossel, have advanced the happy postulate that a bond consists of a pair of shared electrons, shared only by two atoms. With this postulate the hypothesis of shared electrons has proven exceedingly useful.

Accept whichever view of valence mechanism we wish, it is now obvious that the idea of fixed valence for some elements and variable for others is untenable. Every element must be capable of forming compounds through the operation of all its valence electrons, or through the operation of only some of these. Experimental conditions alone must be the determining factor whether a given element will act in its maximum capacity, in some particularly stable valence, or in any other supposedly anomalous valence.

With the discovery, in 1900, of the curious substance which has become known as triphenylmethyl, the idea of fixed valences received a very serious set-back. Here was a substance which, according to all standards of experimental evidence, behaved as if it contained one of its 19 carbon atoms in the molecule in the trivalent and not quadrivalent state. It constituted the first definite example of anomalous valence in the behavior of the very element that had, up till then, shown an unvarying constancy in the tens of thousands of its compounds. Many other similar compounds have been prepared since—not far from a hundred triarylmethyls—and the “trivalence” of carbon is now looked upon as a normal manifestation, for we know fairly well when to expect it and how to recognize it when it does occur. In the early discussions, the historical interest of these substances was emphasized rather than their theoretical bearing. The implied existence of a substance with a carbon atom in trivalent state, was equivalent to stating that an uncompleted molecule can exist, or, in the older language, that a “radical” is a reality and not merely a symbol and a figment of the imagination. It brought back to memory the bitter controversies of the long forgotten past. It recalled the stirring events in the history of chemistry when Gay-Lussac, in 1815, announced the preparation by him of free cyanogen, in which, so he thought, he obtained the first true “compound element” or radical, and that he thus vindicated Lavoisier’s prediction of some 30 years prior. It recalled the days of Liebig and Wohler’s investigation in 1832, of the “Benzoyl” radical; the vigorous and at times somewhat one-sided participation of Berzelius in these controversies, of Berzelius the law-giver in the chemistry of his times. It recalled the joint proclamation of Liebig and Dumas, in 1837, who professed to see locked up in these radicals the very mysteries of organic nature. It brought back to memory the discovery by Bunsen in 1842 of the presumed radical “kakodyl;” by Kolbe, in 1849, of “methyl,” and by Frankland, in 1850, of “ethyl” and “amyl.” It recalled the passionate

and caustic expression of Gerhardt and of Laurent in their bitter opposition to the theory that radicals can exist; it recalled, finally, the fading away of that theory with the advent of the valence hypothesis and the general acknowledgment at that period of the invariable quadrivalence of carbon, so strenuously advocated by Kekule.

#### ANOMALOUS VALENCE IN SOME OTHER ELEMENTS

This represents the historical aspect of the triphenylmethyl episode. A more permanent significance of the triarylmethyls as a class lies in the fact that the study of these compounds has opened the way for analogous studies also with elements other than carbon. By means of methods that are similar to, or not much different from, those which have been employed in the preparation of the free triarylmethyl radicals, it has been fairly well established, through the labors of many investigators, that compounds can exist which contain an atom of the following elements in an anomalous state of valence:  $N^u$ ,  $N^{iv}$ ,  $Si^I$ ,  $O^I$ ,  $Si^{III}$ ,  $Sn^{III}$ ,  $Pb^{III}$ . We know all kinds of free radicals.

A glance at the periodic table shows in what direction the experimental evidence has progressed. Starting with carbon in Group IV, practically all the elements in that group have been shown to act not only as quadrivalent or bivalent, but also as trivalent. Then, one after another, representative elements from the groups to the right of carbon were also found to function with anomalous valence capacity. Nothing, however, of similar nature has yet been done with the elements to the left of the carbon group—almost one-half of the periodic table still remains, in this sense, uncharted sea. To quote from G. N. Lewis: "It is a remarkable fact concerning the metals that we have so far discussed that when they form ions they give off simultaneously all of the electrons of the outer shell. When Ca acts as an electrode in electrolysis, its atom never loses a single electron to form the ion  $Ca^+$ . If it does, this ion must be unstable and react immediately according to the equation,  $2 Ca^+ = Ca^{++} + Ca$ . Compounds of the type  $CaCl$  are unknown. Aluminium does not form the ions  $Al^+$  and  $Al^{++}$ , nor are compounds known of the type  $AlCl$  and  $AlCl_2$ . In other words, when such a metal reacts it uses all of its valence electrons or none."

Recently, in connection with carrying out a Grignard reaction, an observation was made that metallic magnesium, which has been activated by means of iodine, reacts to some extent with benzophenone and small amounts of benzopinacol result, a phenomenon which has been noticed previously by others, but for which no adequate explanation has been given.

Our tentative hypothesis is, therefore, that  $MgI$  is the reducing substance in this reaction. This new reducing agent has been tested out on aromatic aldehydes and esters, and the results indicate that its



action, although more complicated than with ketones, is strictly parallel to that of metallic sodium.

It may be mentioned in this connection that a number of inter-metallic compounds have been described by Desch wherein Mg seems to function as univalent, such as  $\text{AlMg}_3$ ,  $\text{SnMg}_2$ , and  $\text{AuMg}_3$ . May not the enhanced activity of amalgamated magnesium be due to the formation of some  $\text{HgMg}$  and not merely to the fact that the magnesium in solution becomes more certainly monoatomic?

It might be added, that cadmium and zinc have given no indication of forming monohalides under conditions similar to those used with magnesium. Beryllium has not as yet been tested.

To sum up, then, indications have been obtained that magnesium may be forced to function as univalent, in distinction from its normal bivalent state. One may hope that similar methods of attack with other metals may yield more decisive results.

#### CONCLUSION

And so, on the one hand, the study of complex inorganic compounds has led to the conclusion that the valence of many elements may become higher in number than their normal. On the other hand, the study of some complex organic compounds, of the so-called free radicals, proved that some elements may function with anomalous valences, lower than their normal. Concurrently, the physicist, through the momentous advances in the knowledge of atomic structure, has supplied the chemist with a logical concrete picture of the cause and the mechanism of valence manifestation. That picture predicates that, as a matter of course, valence for all but the inert elements must be variable and not fixed.

One may be pardoned, I hope, for attempting to view from this special angle some of the classic experiments of recent times. The determination, by the x-ray method of analysis, of the crystal structure of diamond by Bragg and of graphite by Hull, and by Debe, suggests that in diamond the carbon atom is quadrivalent, but that in graphite the fourth valence is weakened very much, even if not quite to extinction. Again, the positive-ray method of analysis indicates the production from  $\text{CH}_4$  of univalent ions:  $\text{C}^+$ ,  $(\text{CH})^+$ ,  $(\text{CH}_2)^+$ , which proves that the carbon atom in these is univalent, bivalent, and trivalent, respectively, assuming that the positive charge is acquired through loss of a valence electron. By the same method of analysis, according to J. J. Thompson, Hg functions, from  $\text{Hg}^{\text{I}}$  to  $\text{Hg}^{\text{VIII}}$ . And when Millikan has stripped by explosive sparkling some elements of all their valence electrons, the atoms pick these up again, not all at once, but one by one—do not these results also indicate variability of valence capacity?

After the Presidential Address the following committees were appointed:

Committee on Nominations: Fr. Gipprieh, Chairman  
Fr. Shaffrey  
Mr. McLaughlin

Committee on Resolutions: Fr. Phillips, Chairman  
Fr. D. P. Mahoney  
Fr. Love

The minutes of the previous meeting were accepted as printed in the "Proceedings, 1925."

A motion was made, seconded and carried to adjourn.

Thursday, 3.00 P. M. Meetings of the different sections.

Friday, 9.00 A. M. Meetings of the different sections.

Rev. Fr. L. J. Kelly, Provincial of the Maryland-New York Province, was present at the final meeting on Friday afternoon. In his address to the members of the Association he praised their work and laid special stress on the increasing need of men eminent in the Sciences.

The reports of the different sections showed that the following officers were elected for the coming year:

Biology:	Chairman, Rev. C. E. Shaffrey Secretary, Mr. G. J. Kirchgessner
Chemistry:	Chairman, Rev. R. B. Schmitt Secretary, Mr. E. J. Wolff
Mathematics:	Chairman, Rev. E. C. Phillips Secretary, Mr. T. D. Barry
Physics:	Chairman, Rev. J. L. Gripprieh Secretary, Mr. E. J. Nuttall

By a decision of the Executive Council, the Mathematics and Physics sections shall meet hereafter as separate entities.

Fr. Brock spoke on behalf of the Bulletin, urging the members of the Association to contribute more papers. He spoke in praise of the work done by Fr. Shiple and his co-workers at Woodstock in mimeographing the Bulletin and recommended that Fr. Shiple should now be relieved of this burden. Fr. D. P. Mahoney of Holy Cross College then offered to undertake the work during the coming year.

Next followed the report of the Committee on Resolutions. Fr. Phillips read the following resolutions:

"The Association being desirous to show its gratitude for the very cordial welcome extended to it, be it resolved:

"That the President of the Association express in its name to the Superiors of Georgetown University its sincere appreciation of the generous hospitality with which its members have been received during this, the Fifth Annual Meeting of the Association.

"Be it also resolved that a rising vote of thanks be extended to those whose self-sacrificing labors have made possible the continued publication of the Bulletin, in particular to its Editor, Father Brock, and to Fr. Shiple and his co-workers at Woodstock."

Fr. Ahern now spoke on behalf of *La Revue de Questions Scientifiques*, and moved that a resolution of encouragement and sympathy be extended to Fr. Dopp, secretary of the *Société Scientifique de Bruxelles*, with the hope that *La Revue de Questions Scientifiques* will be soon out of difficulty. The motion was seconded by Fr. Phillips and carried.

The report of the Committee on Nominations followed. Fr. Gripprich announced that the committee decided to place one member, Fr. Strohaber, for President, and one, Mr. Quigley, for the office of Secretary. Fr. Ahern moved that the nominations be closed. The motion was carried. A motion was made, seconded and carried to adjourn.

# Papers Read in the Various Sectional Meetings

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## BIOLOGY

### Chairman's Address

#### Atavism

REV. C. E. SHAFFREY, S.J.

Atavism is explained on the basis of the Mendelian Principles of heredity. The term signifies the reappearance in the second or a later generation of plants or animals of some characteristic which existed in some progenitor.

Characters are transmitted from parent to offspring on the chromosomes of the gametes. The chromosomes are of two kinds, the ordinary ones and the X chromosomes or those which have to do with the determination of sex. Most characters are transmitted on the ordinary chromosomes, but many are seen to be linked to the X chromosomes and so are called sex-linked characters. The phenomenon of atavism is explained by the principle of dominance, however the character may be transmitted. Explanation of the facts was made by diagrams. The entire article is to be found in Universal Knowledge under the caption, atavism.

### Use of Anisol in Slide Preparation

REV. F. A. TONDORF, S.J.

This paper dealt with the use of anisol in the preparation of microscopic slides. It was indicated that this method was first suggested by Dr. Becher of the University of Munich. The specific advantages of its use were dwelt upon, as likewise the methods to be followed in its use.

### Early Development of the Nervous System

MR. E. C. DUBOIS, S.J.

The nervous system, which has to do with the receiving of, and the reacting towards, impressions from the outer world, appears to have arisen from the ectoderm. The first obvious trace of the Central Nervous System consists of a thickened area of ectoderm lying on either side of the notocord. (In the chick embryo this can be seen after eighteen hours' incubation).

There is, of course, growth in the area of the medullary plate, at the same time there seems to be a binding down of the medullary plate along the line of the notocord in primitive streaks. These two forces, rapid growth and the binding down, cause the medullary plate to become curved from side to side so as to form a gutter or groove, known as the medullary or neural groove. The lips of this groove are known as the medullary ridges or folds.

Later in development we can notice that the medullary plate keeps on increasing in width and bulges downwards and laterally, and assumes the form of a longitudinally-placed tube with a slit along its dorsal wall representing the original opening of the groove.

The final stage in the formation of the neural tube is the complete fusion of the ridges. This fusion begins in about the middle of the future hindbrain, and proceeds caudally and cephalad. When the ridges are fused completely, the neural tube is separated from the ectoderm of the outer surface.

The neural tube which has originated in the way described, is the rudiment of the central nervous system, its anterior portion becoming relatively enlarged to form the brain, while the remainder forms the spinal cord.

The spinal cord remains throughout life in the form of a tube, the lumen of which becomes relatively insignificant, while the walls become greatly thickened, especially laterally. The relative small size of the lumen, or central canal, is as a rule due merely to its retaining its embryonic dimensions, while the walls of the tube are growing in thickness. On the contrary, actual occlusion of part of the lumen takes in the great majority of the lower vertebrates. The side walls of the tube approach one another so as to convert the rounded lumen into a vertical slit, and finally they come into contact and fuse so as completely to obliterate the cavity except at its ventral portion, which remains open as a definitive central canal.

In the case of birds in which the process has been worked out in detail the increase in thickness is due primarily to the cells composing it, taking on a tall columnar form, the individual cell extending from the central canal to the outer surface. The cell bodies become very attenuated, with a marked dilatation containing the nucleus. The nuclei become necessarily situated at different levels, and this in an ordinary tranverse section obscures the fact that the wall is composed only of a single layer of cells.

With the subsequent development, the cells of the neural tube become differentiated into two products:

- 1) the *nerve cells* whose pre-dominant functions are irritability and conductivity;
- 2) the *neuroglia cells* in which the function is distinctively supporting.

As we stated above, the neural tube is in the beginning but one layer thick. But this does not remain thus, as it becomes many-layered. The cells lose their sharp outlines and form a syncytium, bounded by an internal and external limiting membrane.

Proximate to the internal limiting membrane we find large primitive germinal cells in various stages of mitosis. These primitive germinal cells give rise to the various layers or zones in the neural tube. These zones are three in number:

- 1) The inner or ependymal zone with cells abutting on the internal limiting membrane, and their processes extending peripherally;

- 2) the middle, nucleated mantle zone, where the nuclei are those of the epithelial cells;

- 3) the original zone, a narrow non-nucleated margin appearing in the lateral walls of the neural tube external to the nuclei.

This margin is occupied by the outer ends of the epithelial cells. The ependymal zone contributes cells for the development of the mantle zone. The mantle layer forms the gray substance of the central nervous system, while the fibrous marginal layer constitutes the white substance.

The germinal cells give rise by mitosis to the ependymal cells and to cells characterized as indifferent cells. These later differentiate into two types of cells with variant functions—the spongioblasts and the neuroblasts. The spongioblasts develop into neuroglia cells and fibres—the supporting cells. The neuroblasts are the primitive nerve cells which will develop cell-processes and become neurons.

### **The Thyroid Gland**

MR. H. L. FREATMAN, S.J.

(Abstract)

The thyroid gland was discussed with regard to its anatomical, histological, physiological and pathological aspects, in order to show its importance and prominence in the minds of scientists of today. Iodine seems to be one of the chief constituents of this endocrine gland, and upon its presence depends the healthful functioning of the thyroid. Colloid, the chief element involved in the thyroid's secretion, was briefly considered. The iodine-content varies with season, sex, age, diet, climate, altitude, etc.

After giving a brief history of the study of the thyroid from Berthold in 1849 to Kendall and the like of the present, a cursory glance was made at the abnormal thyroid as seen in Hypertrophy, Hypotrophy and Excision. All the defects of the thyroid seem to point to its importance in the normal functioning of the body, while we pass over with feelings of pity those advanced in Berman's "Glands Regulating Personality."

### **The Word "Species"**

MR. G. J. KIRCHGESSNER, S.J.

The paper was a brief inquiry into the meaning of the word as used by various biologists, with a view to determine the difference in meaning, if any, when the word is used by the philosopher on the one hand, and by the biologist on the other. An attempt was made to give a philosophical definition and then to give instances where the word was used in another sense by biologists. The purpose of the paper was to arouse discussion to throw light on the Theory of Evolution.

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## **CHEMISTRY**

### **Chairman's Address**

**Regulations for the Formation of Student Chapters of the North-eastern Section of the American Chemical Society**

REV. A. J. HOHMAN, S.J.

### **The Evolution of the Chemical Elements**

REV. M. J. AHERN, S.J.

### **Chemistry in the A.B. Course**

REV. T. J. BROWN, S.J.

### **Written Tests and Examinations**

REV. T. P. BUTLER, S.J.

### **The Research Institute of Georgetown University**

REV. G. L. COYLE, S.J.

### **Chemistry Clubs**

REV. H. B. McCULLOUGH, S.J.

### **Vitamin E, the Reproductive Vitamin**

REV. G. J. SHIPLE, S.J.

(Abstract)

It is now recognized that vitamins are as important for reproduction as for growth; and, in the case of rodents at least, a vitamin (variously named E or X) has been discovered which is essential for the generative function.

The evidence for the existence of vitamin E was first proposed in 1922 by Evans and Bishop. It was found to exist in lettuce leaves

(fresh or dry), egg yolk, meat (ox cheek and liver), wheat embryo, oats, alfalfa and milk fat. It is not stored in the body for long periods, is resistant to ordinary cooking temperatures, is insoluble in water, but can be extracted with ethyl alcohol, ether, and with benzene ether and acetone. Later investigations have shown it to be present in yellow corn, hemp seed, cottonseed and olive oils, but not in coconut, linseed or sesame, and alcoholic extracts of wheat embryo and green kale.

Though vitamin E is essential for reproduction, other factors are also to be considered, especially a suitable quantity as well as quality of protein and mineral compounds.

### The Neutral Point

REV. J. J. SULLIVAN, S.J.

To most of us water is the most neutral substance we can conceive. It is neither acid nor basic predominately, and when, according to the Theory of Ionization, a molecule of liquid  $H_2O$  dissociates, it gives rise to one hydrogen ion and one hydroxyl ion, the resulting electrical effect being zero, as is the resultant acid or basic effect.

From mass action considerations we can calculate the resultant hydrogen ion concentration and hydroxyl ion concentration when liquid water thus dissociates. The equation for this dissociation, we know, is



where of necessity the hydrogen ion concentration equals the hydroxyl ion concentration. The mass action expression of equilibrium is

$$(H^+) (OH^-) = K_w$$

that is, the product of the hydrogen ion concentration times the hydroxyl ion concentration equals a constant. At  $25^\circ C.$  the constant equals  $1 \times 10^{-14}$ . That is,

$$(H^+) (OH^-) = 1 \times 10^{-14}$$

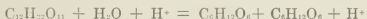
If the hydrogen ion concentration equals  $X$  and this also equals the hydroxyl ion concentration, then  $X^2 = 1 \times 10^{-14}$  and  $X = 1 \times 10^{-7}$ . Thus at  $25^\circ C.$ , in pure water, hydrogen ion has a concentration of  $10^{-7}$  mols and hydroxyl ion has the same concentration. This corresponds, as we know, to  $P_H 7$  for the hydrogen ion and  $P_{OH} 7$  for the hydroxyl ion, according to the modern nomenclature. And so we should expect that the customary neutral solution at  $25^\circ C.$  would have, according to our calculations, the above values, the same values found in neutral water, that is  $P_H 7$  and  $P_{OH} 7$ .

But is this the case? Is  $P_H 7$  the neutral point always found?

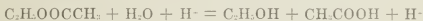


Many experiments go to show that it is not so, and that there are found in actual practice a large number of so-called neutral points. But one set of experiments I should like to review briefly, most of which bear testimony to the fact that  $P_{H7}$  is not *Nature's* neutral point.

These experiments deal with catalysis of various reactions by hydrogen ion or hydroxyl ion, in which reactions the rate of the reaction depends on the concentration of the catalyst, whether it be hydrogen or hydroxyl ion. Examples of hydrogen ion catalysis are the hydrolysis of sucrose:



and the saponification of esters like ethyl acetate;



Both the above reactions are catalyzed by hydroxyl ion as well as many others too numerous to mention now. The fact that these reactions all depend on the concentration of the catalysts whether hydrogen or hydroxyl ion would lead us to ask when these catalysts stop working, that is, when they reach their neutral point. And we might be tempted to suggest that the point of minimum catalytic activity would be just that point in the  $P_H$  concentration scale where the hydrogen ion concentration is equal to the hydroxyl ion concentration, that is, where the acid properties of the hydrogen ions are exactly neutralized by the basic properties of the hydroxyl ions; in other words, at  $P_{H7}$ , the electrical neutral point. We can determine just where this catalytic neutral point is for any given reaction by a few more or less simple calculations which will be given in a footnote to this paper.

Accepting these calculations, which we shall not go through now, we note that at the minimum point

$$H^- = \sqrt{B \times K_w}$$

where  $B$  is the catalytic ratio of the hydroxyl ion and hydrogen ion, and  $K_w$  is the ionization constant of water. We see, then, that at the minimum point the hydrogen ion concentration equals the square root of the catalytic ratio times the ionization constant of water. Here we see that, if the catalytic ratio of the activity of the hydroxyl to the hydrogen ion is unity, the hydrogen ion concentration at 25°C. is

$$(H^+) = \sqrt{K_w} = \sqrt{1 \times 10^{-14}} = 1 \times 10^{-7}$$

a concentration corresponding to  $P_{H7}$ , the calculated neutral point. But the catalytic ratio is seldom unity; for example at 25°C. the

value of B for ethyl acetate, according to some workers, is 1690 and therefore, for minimum catalytic activity at the neutral point, so-called,

$$(H^+) = \sqrt{B \times K_w} = \sqrt{1690 \times 1 \times 10^{-14}} = 4 \times 10^{-6}$$

which corresponds roughly to a  $P_H$  value of 5.4 and not to  $P_H 7$ , the electrical neutral point. (1) (2).

For the hydrolysis of methyl acetate, the minimum point would have a  $P_H$  value of 5.42 (3) and the minimum point for the mutarotation of glucose is 4.64 (5), and so for many other reactions, especially bacteriological (4) and colloidal, the catalytic neutral point, that is, the point of minimum activity, is not the calculated  $P_H 7$ , but some value over toward the acid end of the  $P_H$  chart. Between  $P_H 4$  and  $P_H 6$  seems to be a zone of particular importance in industrial and bacteriological research.

We might ask in conclusion why the neutral point for hydrogen and hydroxyl ion catalysis does not turn out to be the theoretical neutral point, and the answer is that either our calculations are incorrect or the hydroxyl ion is a more active catalyst than the hydrogen ion. As for the calculations, they are ordinary physico-chemical calculations, and accepted by everybody.

Regarding the view that the activity of the hydroxyl ion is greater than the activity of the hydrogen ion, we might say that many chemists today are firm adherents of such a theory. It would seem, therefore, that the hydroxyl ion activity is so great, even at the calculated neutral point, that it overbalances the activity of the hydrogen ion and that it requires even at a concentration of  $P_H 7$  an excess of hydrogen ions, even a concentration as high at times as  $P_H 4$  to lower it to its catalytic minimum or point of catalytic neutrality.

Note: The total catalytic activity for any solution of hydrogen and hydroxyl ions is equal to the sum of the two activities, or setting it formally:

The total catalytic activity (Y) equals the activity of the hydrogen ion (A) times the hydrogen ion concentration ( $H^+$ ) plus the activity of the hydroxyl ion (B) times the hydroxyl ion concentration ( $OH^-$ ); that is

$$Y = A(H^+) + B(OH^-)$$

Assume the activity of the hydrogen ion as unity, whence  $A = 1$ , and that the activity of the hydroxyl ion (B) is the ratio of the catalytic activity of the hydroxyl ion to that of the hydrogen ion and the expression reads

$$Y = (H^+) + B(OH^-)$$

From  $(H^+) (OH^-) = K_w$ ,

$(OH^-) = K_w / (H^+)$  Therefore  $Y = (H^+) + BK_w / (H^+)$

Let  $(H^+) = X$  Then  $Y = X + BK_w / X$

Differentiate:  $dy = dx - \frac{BK_w}{X^2} dx$

Divide through by  $dx$ :  $dy/dx = 1 - BK_w / X^2$

At the minimum point  $dy/dx = 0$

Therefore  $0 = 1 - BK_w / X^2$ , or  $1 = BK_w / X^2$ , or  $X^2 = BK_w$

Therefore  $X = \sqrt{BK_w}$

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#### Chemistry and Bacteriology

MR. V. A. GOOKIN, S.J.

(Abstract)

Nitrogen fixing bacteria.  $N_2$  converted into proteins. Other B. convert these to  $HNO_3$  and basic matter in soil forms nitrates. Fermentation. Theories of Berzelius and Liebig. Pasteur. Yeast plant. Enzymes. Aerobic and anaerobic B. are those that live in presence or absence of free  $O_2$ . Acid-fast B. (e.g. B. tuberculosis) when stained are not decolorized by acid. Other classifications are nitrifying, denitrifying, sulphur and iron B. Action of urase on urea described by Pasteur et al. Denitrifying B. reduce nitrates to liberate  $N_2$  and  $NH_3$ . A nitrogen cycle. Cellulose B. reconvert cellulose to  $CO_2$  and  $H_2O$ . Some anaerobic B. split off  $CO_2$  and  $CH_4$  and if  $CaSO_4$  is present,  $CH_4$  induces formation of  $CaCO_3$ ,  $H_2S$  and  $H_2O$ . Explains presence of  $CH_4$  and  $H_2S$  in bogs. Sulphur stored up by B. Obtained by oxidation of  $H_2S$ . Some B. containing stored-up S ascend to more highly oxygenated planes and S is oxidized. Other anaerobic B. reduce S. A sulphur cycle. Iron B. contain  $Fe(OH)_3$  in cell sheaths. This is passed off as  $Fe_2O_3$ . Explains presence of Fe in "bog-iron." Other B. do the same with Mn. In milk and cheese B. bring about normal or abnormal changes. Spontaneous combustion due to B. e.g. sterilized cotton does not catch fire. Phosphorescence can be

produced by introduction of B. Oxidizing B. yield oxydase.  $O_2$  said to be "carried" by B. Examples of symbiosis are interesting. Two different B. produce two different reactions; but when acting together will produce a distinctly different third reaction, but only when acting together.

### A New Idea for Laboratory

MR. H. C. MACLEOD, S.J.

(Abstract)

Organic:—At Canisius College for the last four years a new method of attacking Organic Laboratory has developed. It seems to have a greater teaching value, it lies in a less restricted field of organic work and gets away from "cook book" chemistry with its isolated experiments. Second semester's work is the synthesis of methyl orange from benzene with the rest of the laboratory work built around it. Starting with benzene, the student gets a yield of nitrobenzene. The actual percentage of yield is calculated, and also the theoretical yield. From this aniline is made, (with the same calculations), then sulphanic acid and the last step, methyl orange.

In the synthesis students work in pairs and competition between sections of laboratory is keen, the actual yields being posted. This synthesis brings out such steps as nitration, diazotization, reduction and sulphonation, showing the practical application of these processes by taking them through an industrial process. At present a companion synthesis is being worked out for Aspirin from benzene, through nitrobenzene, aniline, phenol and salicylic acid.

Inorganic:—To get away from the old fashion, descriptive, illustrative method of teaching inorganic chemistry and to get as much out of the course as possible, a new procedure was introduced at Canisius College wherein the laboratory was made the central feature of the course. The texts used were Hildebrand—"Principles of Chemistry" and, (for laboratory), "Course in General Chemistry" by Bray and Latimer of the University of California. The laboratory work is quantitative in nature, but not analytical. In lecture the professor lectures on descriptive chemistry, and illustrates his lectures by the experiments the students would have done in the ordinary course. In laboratory, however, principles are brought out—principles, laws and theories, great stress being laid on the Ionic Theory. This is of advantage to the Pre-medical students. The question "how much" is constantly before them and not "what are the properties"—which is of advantage to students with an industrial turn of mind. Three-quarters of the course is concerned with equations, mathematics and a great deal of "thinking for one's self." Columbia University accepts this course, (with a summer school course equivalent to a half

year course), for the two years which they demand as a prerequisite for their engineering school.

### **The Present Status of Nutritional Chemistry**

MR. F. W. POWER, S.J.

(Abstract)

The recognition of accessory food factors or *vitamines* was made possible by extensive animal investigation and by close co-operation between different groups of scientists, each working in his own special field, but frequently conferring and comparing notes as to the progress of the experimental work and the conclusions to which it led. The institutions chiefly responsible for this work are Cambridge in England, and Yale, Columbia, and Johns Hopkins in this country.

The vitamine hypothesis is an outgrowth of the earlier work in Nutritional Chemistry in which the energetic value of foodstuffs was emphasized. In addition to this essential feature of Nutritional Chemistry, a great amount of experimental work, (a certain phase of it carried out at Fordham), has drawn a distinction between the essential and the non-essential amino acids in our protein foods; while other investigations have shown the great necessity of certain minute amounts of inorganic substances in the diet, notably Ca, P, I, and Fe. The early investigations on the energetics of foodstuffs also served as a foundation for the more recent work on insulin and thyroxin.

The basic requirements for a well-balanced diet are now well known, although the translation of them into a series of edible meals over a long period of time is a very difficult task; and it is suggested that in our large houses it be taken over, or at least checked from time to time, by a competent dietitian. This matter of proper food is of obvious importance, and there is so much definite scientific information on it now at hand that it is a pity not to avail ourselves of it.

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## **MATHEMATICS**

**Chairman's Address**

**The Principal Caustic of a Spiral Mirror**

REV. E. C. PHILLIPS, S.J.

This paper dealt with the problem of finding the caustic curve produced by the reflection of rays of light proceeding from a point source placed at the pole or center of a cylindrical mirror having the shape of a logarithmic spiral.

The equation of the spiral was taken in the form:  $r = a\sqrt{\theta}$  where  $r$  and  $\theta$  are the polar co-ordinates of a point, and  $a$  is an arbitrary constant. The solution of the problem considered mathematically consists in finding the envelope of the system of straight lines constituting the reflected rays determined according to the usual geometric relation existing between incident and reflected rays. The equation of the envelope was found to be  $r = a\sqrt{(\theta + \theta')}$ , where  $\theta'$  is constant angle. As this equation differs from the original one only by the addition of a constant to the exponent of  $a$ , it follows that the envelope or caustic curve is simply the original curve (mirror) rotated through the angle  $\theta'$ .

#### **Application of the Parametric Equations to the Parabola**

REV. J. L. GIPPRICH, S.J.

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### **PHYSICS**

**Chairman's Address**

#### **"Foundations of Relativity"**

REV. J. L. GIPPRICH, S.J.

#### **The Vacuum Tube Amplifier and Some of Its Applications**

REV. H. M. BROCK, S.J.

The invention and development of the thermionic vacuum tube has placed an instrument of marvelous sensitivity in the hands of the physicist. It has found numerous applications not only in radio transmission and reception, but also in other fields of research. The purpose of this paper is a discussion of the tube considered as an amplifier and of some of the uses to which it has been put in recent years. As is well known, a single tube has inherent amplifying power. A slight change in the grid potential produces a much greater change in the plate current than the same change in the voltage of the plate circuit. The amplification factor is the ratio of the plate and grid potential variations which will produce the same variation in the plate current. This amplifying effect may be increased by sending the modulated plate current of the tube into the primary or a step-up transformer whose secondary is connected to the grid and filament of a second tube. Or a high resistance may be inserted in the plate circuit and its terminals connected to the grid and filament of the second tube. Additional tubes may be connected in the same way. Such tubes, called amplifiers, are most commonly used in radio. Their functions and the more common circuits employed are

so familiar that there is no need to dwell upon them here. Among other applications made in recent years the following may be mentioned.

In 1919 Hall and Adams used an amplifier in measuring the conductivity of electrolytes. They used the ordinary bridge arrangement, but instead of detecting the balance by means of a telephone or galvanometer an amplifier was inserted in their place with a telephone in the plate circuit of the last tube. The sensitivity of the bridge was thus very considerably increased even with weak currents. In 1919 Barkenhausen studied the earth currents set up between two earthed electrodes 100 meters apart by connecting the latter with a high power amplifier. A telephone was used as a detector. Curious effects were obtained. At times a note would start at the highest audible limit and range through all frequencies to the lowest. He also found that the sound produced by varying the magnetization of iron could be rendered audible in a similar manner. When light falls upon a photoelectric cell electrons are emitted which give rise to a minute current. In 1920 Meyer, Rosenberg and Tank increased the effect by connecting the cell with an amplifier. With ratios up to 125,000 a strict proportion was found between the unamplified and amplified current. The photoelectric current could thus be easily studied and measured.

Whiddington in 1920 devised his Ultra-micrometer which, it is claimed, can measure distances of the order of atomic diameters. The measuring device is composed of two parallel metal plates forming a condenser. This serves as part of an oscillating circuit connected with an amplifier and loud speaker. By means of a second oscillating circuit a beat note can be set up in the latter. The slightest change in the distance between the plates changes the capacitance of the condenser and produces a change in the beat note. Hanford employed a somewhat similar method to study minute slipping of metals. It was found as early as 1866 that when the excised eye of a frog is illuminated with light a galvanometer connected between the cornea and optic nerve indicates a minute current. This phenomenon has since been studied in detail. Bovie, Chaffee and Hampson were the first in 1920 to employ an amplifier to study this electrical response of the retina under the stimulus of light. The inner eye and the optic nerve were connected to the grid and filament of a three electrode tube resistance coupled with a second amplifying tube. The latter was connected with an Einthoven string galvanometer whose deflections were photographed.

In 1923 Tolman, Karrer and Guernsey greatly improved the technique of the experiment of Tolman and Stewart which gave evidence of the existence of mobile electrons in a conductor which act as current carriers. A metal cylinder was oscillated about its axis in such

a way as to eliminate the effect of the earth's magnetic field. The inertia of the mobile electrons causes them to move forward slightly when the cylinder reverses its motion, thus producing a small alternating current. The latter induced a second current in a coil of a large number of turns surrounding the cylinder. This induced current was greatly amplified by means of three tubes. A vibration galvanometer was used as a detector. Thus the sensitivity of the apparatus was increased and the mass of the mobile electron was found to agree quite closely with that of the free electron. In 1925 Jouast and Mesney worked out a method of telegraphing the time of transit of a star to navigators without personal error. The light from the star crossing the meridian fell upon a photoelectric cell. The resulting current was amplified a million by tubes whose output was connected with a radio transmitter.

### **Light and Color**

REV. T. J. LOVE, S.J.

This paper briefly contrasted the Ether Theory of light with a newer theory. This latter theory was the one presented by a Mr. Burns of Los Angeles. Instead of a continuous ether, with its somewhat contradictory properties, Mr. Burns postulates a practically unlimited number of complex, ponderable bodies, called ions, permeating all space and all physical substances. They are not propelled into space, but already filling all space, they are energized by some source of radiant energy. The propelling energy is electro-magnetic. By means of these energized ions the various phenomena of reflection, refraction, diffraction, interference and polarization are explained. Color phenomena are explained in accord with the principles of this newer theory.

### **Father Carl Braun, an Appreciation**

REV. F. J. TONDORF, S.J.

This paper was a short biography of Fr. Braun, to which was appended his figures on the mass of the earth. It was particularly insisted upon that Fr. Braun was the first to determine the earth's mass with a pendulum enclosed in vacuo. It was stated that, at the time of the reading of the paper, Dr. Heyl of the United States Bureau of Standards was re-attacking the problem to ascertain the accuracy of the estimates of Fr. Braun. It may be added that at the recent meeting of the Geophysical Union held at the National Academy of Science, Washington, D. C., Dr. Heyl made public his findings. He finds the figures of Braun correct to the third decimal place.

### **The Mercury Turbine**

MR. L. F. FEY, S.J.



### **The Teachings of Physics in Secondary Schools**

MR. J. J. LONG, S.J.

The paper gave a brief historical sketch of the teaching of secondary school physics. A comparison was made between the older methods, when physics was treated under the head of Natural Philosophy, and the more modern methods. The period of 1880 to 1890 was treated at length, as much that we are striving for in secondary school physics was then advocated. A brief resumé of the inductive method was made, difficulties pointed out and solutions suggested.

### **A Uniform Laboratory Manual**

MR. T. L. McLAUGHLIN, S.J.

(Abstract)

Due to the ever increasing demands on our Physics departments it seems advisable that some effort should be made to lessen the burdens of the now over-taxed professor. Besides the necessity of equipping our departments with proper and suitable instruments, and at the same time with the greatest possible economy, it seems proper at this time to introduce some uniformity into our Physics classes. To this end, as a first step, a uniform laboratory manual is suggested, as a saving of time and labor to the professor, and by thus unifying the experiments the way may be opened to the appointment of one man as an agent for the entire body, who could demand from the Scientific Corporations a discount suitable to our yearly expenditures.

### **Rectifiers**

MR. E. J. NUTTALL, S.J.

### **The Airplane**

MR. J. G. TYNAN, S.J.

The paper was an elementary treatise dealing with the construction and flying of a standard Army training plane, together with a discussion of the theory of flight and some engineering problems of aerodynamics. A Curtiss biplane was selected as a standard and its elements and mode of construction discussed. Attention was given the various types of planes and their relative advantages. A Barmecide flight took the listeners aloft and illustrated the meaning and use of the various movable surfaces. The paper was illustrated by slides kindly loaned by the United States Army.

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- Logue, Louis R., 1923. Woodstock College, Woodstock, Md.
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- Long, John J., 1924. Georgetown College Preparatory School, Garrett Park, Md.
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- Lynch, Rev. John J., 1922. Valkenburg, Limburg, Holland.
- Mahoney, Rev. Daniel P., 1924. Holy Cross College, Worcester, Mass.
- Mahoney, Rev. James B., 1925. Ateneo de Manila, Manila, P. I.
- McAree, Rev. Joseph F., 1923. St. Joseph's College, Philadelphia, Pa.
- McCormick, Rev. James T., 1923. Boston College High School, Boston, Mass.
- McGarry, Rev. William J., 1923. St. Andrew-on-Hudson, Poughkeepsie, N. Y.
- McLaughlin, Thomas L., 1923. Woodstock College, Woodstock, Md.
- McNally, Herbert P., 1922. Woodstock College, Woodstock, Md.
- McNally, Rev. Paul A., 1923. St. Ignatius College, San Francisco, Cal.
- Merrick, Joseph P., 1923. Woodstock College, Woodstock, Md.
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- Moore, Thomas H., 1923. Woodstock College, Woodstock, Md.
- Murphy, John J., 1922. Woodstock College, Woodstock, Md.
- Nuttall, Edmund J., 1925. Georgetown University, Washington, D. C.
- O'Connor, John S., 1923. St. Louis University, St. Louis, Mo.
- O'Donnell, George A., 1924. Woodstock College, Woodstock, Md.
- O'Laughlin, Rev. Francis D., 1923. Fordham University, New York, N. Y.
- O'Mahony, Timothy J., 1926. Boston College High School, Boston, Mass.

- Phillips, Rev. Edward C., 1922. Georgetown University, Washington, D. C.
- Quigley, Thomas H., 1925. Holy Cross College, Worcester, Mass.
- Rafferty, Rev. Patrick, 1923. Cagayan, Misamis, Mindanao, P. I.
- Reith, Rev. Joseph, 1922. Woodstock College, Woodstock, Md.
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